Explaining Differences in Global Climate Sensitivity among IPCC Models and Determining the Contributions of Various Radiative Feedbacks

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15 July 2004

We expect that simulations of future climate change performed in preparation for the IPCC Fourth Assessment Report will, as in the past, yield a range of predictions, with global mean equilibrium climate responses differing by perhaps a factor of two. Although the model predictions of climate change for a few decades from now will likely vary by a substantially smaller amount (because in transient climate change, ocean heat uptake tends to moderate differences in climate sensitivity), the reasons for differences in global climate sensitivity can shed light both on why models differ, and also on which feedbacks are largest and most important to get right. Thus, the uncertainty in future predictions of climate change can be better gauged if the feedbacks are better understood.

We propose to analyze feedbacks in the climate models by focusing primarily on the idealized coupled model experiments involving 1% per year increases in CO_2 and the slab ocean equilibrium experiment in which CO_2 is doubled. These idealized experiments are the easiest to analyze because the CO_2 radiative forcing scales logarithmically with concentration. If the modeling groups calculate clear-sky and all sky CO_2 radiative forcing for a doubled concentration of CO_2, we will be able to use methods for estimating feedbacks by monitoring the fluxes of radiation at the top of the atmosphere. We should be able to gauge the relative importance of shortwave and longwave cloud feedbacks (due to overall cloud fraction changes as well as changes in the combined effects of distribution and optical propoerties), surface albedo feedbacks (e.g., due to snow, sea ice, vegetation changes) and also the combined effects of water vapor and lapse rate.

We expect to consider not only the global differences in feedbacks among the IPCC models, but also their spatial and perhaps seasonal differences. If modeling groups calculate the radiative forcing in the other scenario simulations, we will also analyze these using the same methods.